The Report committee for Lee D Saeugling Certifies that this is the approved version of the following Report:

THE EFFICACY OF NEXERSYS TRAINING FOR IMPROVING BODY COMPOSITION AND CARDIOVASCULAR FITNESS

Approved By

Supervising Committee:

Supervisor: _____

Edward F. Coyle

_____

Robert M. Brothers

THE EFFICACY OF NEXERSYS TRAINING FOR IMPROVING BODY COMPOSITION AND CARDIOVASCULAR FITNESS

by

Lee Daniel Saeugling, B.S

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Abstract

THE EFFICACY OF NEXERSYS TRAINING FOR IMPROVING BODY COMPOSITION AND CARDIOVASCULAR FITNESS

by

Lee Daniel Saeugling, M.S. Kin.

The University of Texas at Austin, 2013

SUPERVISOR: Edward F. Coyle

Purpose: This is the first study done to determine the efficacy of 10-weeks of Nexersys training on improving cardiovascular fitness (CF) and body composition (BC). Nexersys is an "exergaming" system that combines mixed martial arts, high-intensity interval training and core work into an interactive unit with a monitor and 7-strike pads. Participants were provided a Nexersys unit in their homes to complete 10-weeks of training 3 to 4 times a week progressing from 5, 3-min rounds with a minute rest to 15 rounds at the end of 10-weeks. Participants were tested on 3 separate occasions, prior to beginning training (0wk), at 5-weeks (5wk) and 10-weeks (10wk). Body mass (BM), percent body fat (%BF), fat mass (FM) and lean mass (LM) were assessed using dual-energy X-ray absorptiometry (DEXA). CF was assessed during a 10-round Nexersys bout

(NB) and a VO_2max treadmill (VO_2max) test. CF during NB and VO_2max treadmill test was assessed by using regression analysis to determine the estimated average heart rate for a range of VO_2 10-25 ml/kg/min (HRN) and 10-30 ml/kg/min (HRV) respectively.

Results and Conclusion: Relative to starting values, BM did not change (79.8 ± 7.9 to 79.7 ± 7.5 kg). %BF and FM decreased from starting values (36.0 ± 3.4% to 34.1 ± 5.3%, p=0.003 and 30.0 ± 4.9 kg to 28.4 ± 4.6 kg, p=0.045, respectively). LM increased from starting values (46.7 ± 3.5kg to 48.4 ± 3.6kg, p=0.001). HRN and HRV decreased from starting (148 ± 2.7 to 140.8 ± 1.9 bpm, p=0.003 and 148 ± 1.8 to 140.1 ± 1.8 bpm, p=0.003, respectively). VO_2max trended to increase but did not reach statistical significance (33.9 ± 1.7 to 36.3 ± 1.7 ml/kg/min, p=0.054). These findings suggest 10-weeks of Nexersys training improves body composition both by increasing LM and decreasing BF with no change in BM. CF improved at submaximal intensities.

TABLE OF CONTENTS

ACKNOWLEDGMENTS……..iii

ABSTRACT……...iv

INTRODUCTION……...1

LITERATURE REVIEW……4

Traditional Exercise Modalities……...5

Non-Traditional / Emerging Fitness Modalities……..9

METHODS……11

Subjects……..11

Experimental Design……..11

Experimental Protocol……...11

Statistics and Calculations……12

RESULTS……..14

DISCUSSION……18

APPENDIX A……21

APPENDIX B……24

REFERENCES……..31

Introduction

According to the Center for Disease Control (CDC) one third of the US adult population is obese [20]. Obesity and its associated diseases - including type 2 diabetes, cardiovascular disease, some cancers (endometrial, postmenopausal breast, kidney and colon), musculoskeletal disorders, sleep apnea and gallbladder disease are not only a health crisis but a fiscal crisis as well. Finkelstein et al. found that medical expenses for weight-related health issues in the United States in 1998 were as high as $78.5 billion, with Medicare and Medicaid financing approximately half of these costs [21]. Both the American College Of Sports Medicine (ACSM) and the US Department of Health and Human Services recommend exercise as a way to reduce the prevalence of obesity related disease [3, 22, 23].

Despite the broad public knowledge of the health and financial benefits of exercise, getting individuals to maintain a long-term exercise regime is difficult. Consequently, the ACSM recommends the use of a customized training plan under professional supervision to guide the individual through the work-out, as well as a work-out that is fun and engaging to improve an individual's compliance with an exercise routine [3]. The ACSM recommends that adults engage in moderate-intensity cardiorespritory exercise training for $\geq$30 minutes per day for $\geq$5 days per week for a total of $\geq$150 min per wk; vigorous-intensity cardiorespiratory exercise training for $\geq$20 minutes per day for $\geq$3 days per week for a total of $\geq$75minutes per week; or a combination of these two programs [3].

VO_2max is an important variable when assessing cardiovascular fitness. The ACSM review concluded that well trained athletes and moderately trained athletes require a threshold intensity for improving VO_2max of 95%-100% and 70%-80% VO_2max respectively. The ACSM could not establish a threshold intensity for raising VO_2max in individuals with a VO2max <40 ml/kg/min [3]. Unfortunately the ACSM does not specify the duration at these intensities necessary to improve VO_2max. Poole and Gaesser found that interval training 3 days/week; with 10 x 2 min intervals at 105% VO_2max significantly increased VO2max from baseline [24]. Our study measured VO_2max on three separate occasions (before program, at 5 weeks and 10 weeks) to assess the impact of training. Our study did not track intensity of the training done at home. Subjects were encouraged to follow the instructions given by the Nexersys as closely as possible, but ultimately they were still self-selecting intensity during training.

The Nexersys exercise machine based on mixed martial arts and specifically, kick-boxing, was created to meet the needs of high intensity activity, to be an interactive machine to encourage compliance, and elicits quick reaction times to improve mental capacity and mood. It is a total body workout machine and has an interactive trainer who leads you through a workout customized both in activity and duration. The Nexersys machine is comprised of seven pads that respond to the individual's punches and kicks with a central screen that motivates and instructs. The exercise protocol consists of 3-minute rounds followed by 1 minute of rest. The user is able to build a personalized routine from striking, cardio, or core based rounds. Alternatively, individuals may use the Avatar gaming based rounds that require quick reaction times and give constant feedback about frequency and power of strikes. Subjects in this study used the preprogrammed

bouts ranging from 5 to 15 rounds. Overall the machine is structured in varying levels of difficulty and intensity ranging from “light and fun” to “vigorous and competitive” so that a variety of users can benefit.

The Nexersys is one of many interactive, video-based exercise systems known as “exergaming.” Among the most well known exergaming systems are the Nintendo Wii, Playstation 2 and Dance Dance Revolution. The Nintendo Wii, for example, has games for tennis, golf, yoga and martial arts. Exergaming systems are increasingly considered a viable fitness option, especially in truly sedentary individuals in place of traditional exercise modalities like circuit training or low-intensity aerobic activity [6, 7, 11].

Several features make the Nexersys system unique from both a consumer and research standpoint. Unlike the Nintendo Wii or other videogame-style systems, Nexersys users can make direct contact with the machine, allowing for a more realistic simulation of the activity (in this case, martial arts). The Nexersys software guides the user through workouts that are periodized on both a microcycle and macrocycle, allowing for progressive overload. Nexersys workouts can also be used to target a range of adaptations: cardiovascular fitness, martial arts neuromuscular skill training, martial arts strike patterns, and core / abdominal strengthening. Workouts can therefore be designed to achieve various goals: general health and fitness, improved martial arts skills, weight loss / body composition improvement or aerobic endurance.

Literature Review

The Nexersys combines martial arts type training with high intensity cardiovascular circuit training. There are currently no studies that have been done on the Nexersys' efficacy for improving cardiovascular fitness and body composition. Therefore this literature review will seek to establish a framework with which the efficacy of the Nexersys can be evaluated. This literature review will use the American College of Sports Medicine's 2011 Position Stand on exercise recommendations as its guiding framework (Garber et al 2011). The review will address the effect of various exercise modalities on their efficacy for improving cardiovascular fitness (VO_2max) and body composition.

Guidelines for Physical Activity

The American College of Sports Medicine's Position Stand on exercise recommendations is based on a comprehensive review of the exercise literature as it relates to non-pathological, non-athletic adults. For cardiorespiratory fitness, the ACSM recommends adults perform 30-60 minutes of "moderate" (65% of VO_2max) exercise 5 times per week; or 20-60 minutes of "vigorous" (80% of VO_2max) exercise 3 times per week. In sedentary individuals, the threshold exercise intensity to improve VO2max may be as low as 45%, although this threshold increases with training state. A moderately trained athlete will require training at 75-80% VO_2max in order to see an improvement; and experienced, endurance-trained athletes need to in excess of 95% of VO_2max to induce the desired adaptations [3].

Traditional Exercise Modalities

Effect on Body Composition and Weight

A reduction in weight and improved body composition is a main goal of many individuals that start an exercise program. Forbes (17) assessed the body composition and weight change in 41 college students and young adults that participated in exercise programs of 1-10 months on ad libitum diets. The subjects self-selected their exercise programs. Subjects participated in running, bicycling, body-building and varsity football practice. Forbes also evaluated published reports of the effects of various exercise programs on body composition. Some studies had their subjects eat ad libitum, whereas others had their subjects on a low-calorie but protein adequate diet. Forbes found that for the subjects he studied an average of 0.5 kg of lean body mass (LBM) was gained or loss for every 1 kg of total body weight gained or lost. Similarly, Forbes found in the published studies he evaluated that there was a direct relationship between changes in LBM and changes in weight. This was true regardless of whether or not the subjects were on a low-calorie diet or an ad libitum diet. Forbes found that there was a difference between the slope of ΔLBM vs. Δweight in subjects that were relatively thin or fat. With greater ΔLBM for a given Δweight in thin subjects [17]. This indicates that weight change in fatter individuals involves a larger portion of fat than thinner individuals.

Garrow et al. (18) did a meta-analysis of twenty-eight publications that reported the effect of exercise on body composition changes in sedentary men and women. Garrow et al. found that aerobic exercise with an ad libitum diet caused a 3 kg weight loss in 30 weeks in men, and a 1.4 kg weight loss in 12 weeks among women. However there was little change in free fat mass (FFM) in these subjects. Garrow et al. found that

resistance exercise was not effective for weight loss and in fact increased FFM by 2 kg in men and 1 kg in women. Using regression analysis Garrow et al. found that for a 10 kg weight loss induced by exercise and caloric restriction the expected FFM loss is 1.7 kg [18]. This is in agreement with Forbes (17) in that a substantial portion of weight loss from exercise is not from FFM.

These findings suggest that it is unlikely for an exercise program to both induce weight loss and maintain or increase LBM. Individuals must prioritize either weight loss or gains in LBM. These finding suggests that those with more fat prioritize weight loss and thinner individuals' increases in LBM to improve body composition.

Effect on cardiovascular fitness (VO_2max)

One of the most effective forms of cardiorespiratory training is interval training, where the subject conducts repeated short bouts of high intensity exercise interspersed with recovery periods no greater than the duration of the exercise bout. Helgerud et al. (4) showed that two different interval training protocols at 90-95% of maximum heart rate significantly improved VO_2max in healthy, moderately trained men; and that these protocols were significantly more effective than low-intensity exercise (long distance running at 70% maximum heart rate) or moderate-intensity exercise (running at 85% maximum heart rate). Helgerud's high intensity protocols were 47 segments of 15 seconds high intensity alternating with 15 seconds of active recovery at moderate intensity and 4 x 4 minutes of high intensity with 3 minutes of active recovery between bouts. The percent improvement in VO_2max for the 15/15 and 4 x 4 were 5.5 and 7.2%

respectively. Due to the difficulty of administering the former program, Helgerud recommended an exercise program with longer intervals to improve VO_2max [4].

Circuit training is a popular exercise modality among the general health and fitness population, as it combines aspects of both aerobic and strength training. Peterson et al. (13) found that high-intensity interval-style circuit training can significantly improve VO_2max in trained subjects. Over a 5-week period, Peterson's subjects increased their VO_2max by 9.5%. The exercise protocol involved 2 20-second exercise bouts separated by 20 seconds of rest at each station; 60 seconds of rest after each station; and 4 minutes of active recovery between circuits [13]. The subjects showed no change in maximum heart rate or body weight, likely due to their training status at the beginning of the study. An important feature of Peterson's program design that was not found in other studies they cite is a progressive overload in the amount of resistance across the 5 weeks of the study.

Mosher et al. (10) examined the effects of a combined aerobic and circuit-training program on untrained women. Their protocol combined 5 3-minute bouts of aerobic exercise at 75-85% of VO_2max with 25-30 min of weight training at 40-50% of their 1-repetition maximum. The subjects showed significant improvements in both their VO2max and 1RM on several of the strength exercises, leading Mosher to draw attention to the fact that the strength and aerobic components of the protocol did not compromise the subjects' adaptations, as is sometimes reported [10]. Unfortunately Mosher did not report the percentage increase in VO_2max only that it was significant.

Generalizing findings across modalities

One difficulty that confronts health and fitness professionals, their clients and exercise researchers is the limited research on energy expenditure and workload during resistance circuit training. The ACSM position stand talks about the musculoskeletal adaptations that can be induced through resistance training, but this is addressed distinct from other modalities of exercise or potential applications of resistance training to fitness goals other than strength, hypertrophy or general musculoskeletal fitness. This gap in the literature makes it difficult to compare workloads and exercise intensities across exercise modalities; as well as assessing the cross-over effects of adaptations being induced by a "non-traditional" form of exercise. Peinado et al. (12) measured subjects' heart rate and oxygen consumption during circuit weight training. They also determined their subjects' body composition using a skinfold-caliper technique. In this pilot study, Peinado found through regression analysis that workload could be predicted by a series of equations incorporating maximum heart rate, highest percentage of HRmax obtained during exercise testing and average percentage of HRmax during exercise. The data also showed that energy expenditure differs significantly with exercise intensity when controlling for the subject's body weight and muscle mass. Peinado offers their equations as a safer alternative than 1-repetition maximum to determine workload [12]. They also represent a way to compare the amount of time a client performs a given exercise at a given intensity, which may be relevant to determine the applicability of an exercise protocol to the ACSM's position stand on exercise intensities for cardiorespiratory health.

Non-Traditional / Emerging Fitness Modalities

Sell's (14) study of "non-traditional" exercise modalities compared the energy cost and physiological responses to walking, an interactive boxing video game using the Nintendo Wii and indoor rock climbing. Among the 24 healthy college-aged subjects, there was no difference between walking and the Nintendo Wii boxing game in the subjects' heart rate, oxygen consumption, %VO_2max, or RPE. Consequently, Sell et al. conclude that Nintendo Wii's boxing video games are "low intensity" exercises under the ACSM and American Heart Associations guidelines, and are therefore insufficient for general cardiorespiratory health and fitness [14].

Dawes et al. (2) studied the effects of Nintendo Wii training among university students, and produced results similar to Lanningham-Foster (6) in that exercise based on the Wii was preferable to no exercise at all; but would require training structure and oversight in order to achieve consistent and significant results for body composition and general fitness [2]. Likewise, Worley et al. (15) found that while there was a significant difference in the oxygen consumption between intermediate and beginner levels of two Wii Fit games, neither required greater than 30% of VO_2max [15]. The low levels of energy expenditure above a sedentary baseline likely underlie Maddison's (8) finding that among overweight and obese adolescents; no significant change in body mass index (BMI) was seen until after 24 weeks of exercise using the Playstation EyeToy system [8].

Jordan (5) compared the Nintendo Wii and the PlayStation2 to walking and cycling in healthy untrained males [5]. The results indicate that the PlayStation2 was a better alternative, and resulted in energy expenditure equivalent to cycling at 120W. However, the protocol used for the PlayStation2 recruited lower limb muscles whereas

the Wii Fit solely used the upper limb. Consequently, while the PlayStation2 exercise was at the low end of the ACSM's guideline for aerobic exercise the Wii Fit was not within the range. Jordan attributes the difference to the increased muscle mass recruited by the PlayStation2 protocol as being necessary for sufficient oxygen consumption under the ACSM guidelines.

Methods

Subjects: Ten sedentary individuals (5 male and 5 female) provided written informed consent to participate in this study. One male subject was unable to complete the study. The 4 male and 5 female subjects who completed the study were 31.2 ± 6.2 years of age. The experimental design, protocol and informed consent were approved by the Institutional Review Board at The University of Texas at Austin. The subjects' body mass, percent body fat, lean mass and maximal oxygen consumption (VO_2max) (means ± SE) at the beginning of the study were as follows: 79.8 ± 7.8 kg, 36 ± 3.4 %, 46.70 ± 3.52 kg, 33.9 ± 1.7 ml/kg/min, respectively.

Experimental Design: Subjects completed 10-weeks of training consisting of 3 to 4 training sessions per week. Each subject was provided a Nexersys and all training was done at his or her homes. Training sessions started with 5 3-minute rounds with 1-minute between rounds and progressed to 15 rounds by the end of the training. The exact training schedule can be found in Table 1. Subjects were assessed prior to training (0wk), at 5-weeks (5wk) and on completion of the 10-weeks (10wk). Subjects were instructed to maintain their current activity level with only the addition of the Nexersys training. Subjects' were not instructed regarding eating patterns and their diet was ad libitum.

Experimental protocol: Familiarization was performed during a visit to the laboratory. Familiarization consisted of instruction on striking, cardio, and core exercises that would be performed during testing. Subjects then did 3 striking rounds and 2 cardio

rounds. The second cardio round was performed with the headgear and mouthpiece for indirect calriometry.

Subjects reported to the lab three times for testing at 0wk, 5wk and 10wk. The testing consisted of a 10-round Nexersys bout (NB), body composition testing using DEXA and a treadmill VO2max test. The NB rounds were as follows: beginner cardio (CB), beginner follow me (FMB), 120 strikes (jab-cross) per min, FMB, beginner core (BC), 8 squat-jump-kicks (SJK) per min, FMB, 16 SJK per min, advanced cardio (CA), and CA. Continuous collection of heart rate (HR), VO_2 and VCO_2 was performed throughout the NB and averaged every 30sec. The VO_2max test was performed 25min after the completion of the NB. The VO_2max treadmill test was a ramp protocol. The speed was set to elicit a HR of approximately 160 bpm while running on the level. The ramp protocol was as follows: 4 minutes at 0% grade at the determined speed, increased grade to 4% for 2 minutes and every 2 minutes was raised an additional 2% until volitional fatigue.

Statistics and Calculations: All statistics were done using IBM SPSS statistics 20. All variables were analyzed by doing a one-way repeated measure ANOVA. Pair-wise comparisons were used to assess differences between week 0, week 5 and week 10. Statistical significance was set at $p<0.05$.

To assess changes in submaximal heart rate over a range of oxygen uptake values HR and VO_2 were averaged every 30sec during the NB and treadmill VO_2max test. Regression analysis was used to generate a formula that would estimate HR for any given VO_2. A HR was then calculated for a range of submaximal relative VO_2 values

(ml/kg/min). The HR was then averaged over this range. This was done both for the NB and treadmill running. The range of VO_2 values were chosen because they were representative of what was seen during each activity. For this reason the NB VO_2 range is slightly lower at 10-25 ml/kg/min than treadmill 10-30 ml/kg/min because a VO_2 of 30 ml/kg/min was not seen in all subjects during NB but was during treadmill running.

Results

%VO_2max and %HRmax During Nexersys

The average %VO_2max during the NB was 50.0% and did not vary between 0wk, 5wk and 10wk. The average %HRmax during the NB was 79.1% and did not vary between 0wk, 5wk and 10wk. Subjects spent 400 ± 47.7sec >70% VO_2max and 37min >70%HRmax. A comparison of %VO_2max and %HRmax can be found in Figure 1. Subjects achieved a VO_2 > 70% VO_2max during the 3 cardio rounds of the NB. They averaged 133.3sec with VO2 > 70% VO_2max per cardio round.

Maximal Oxygen Uptake

The subjects VO_2max at 0wk was 33.9 ± 1.7 ml/kg/min and ranged from 27.1 to 41.8 ml/kg/min. At 5wk the subjects VO_2max had increased non-significantly 1.8% p=1.0 to 34.5 ± 1.2 ml/kg/min. At 10wk the subjects VO_2max had increased non-significantly 7.1% to 36.3 ± 1.7 ml/kg/min from 0wk (p=0.054). (Figure 2)

Submaximal HR

Heart Rate during 10 Rounds of Nexersys (NB)

HR and VO_2 was averaged every 30sec during the NB. Regression analysis was used to generate a formula that would estimate HR for any given VO_2. An average HR was then

calculated over a range of submaximal relative VO_2 values (10-25 ml/kg/min). At 0wk the average HRN based on the above analysis was 148 ± 2.7 bpm. At 5wk the average heart rate decreased significantly by 3.9%, to 142.3 ± 2.2 bpm (p=0.001). At 10wk the average heart rate had decreased significantly 4.9%, from 0wk to 140.8 ± 1.9 bpm (p=0.003). There was no difference between the average HR at 5wk and 10wk, p=1.0. (Figure 3)

Heart Rate during Treadmill Running

Similar to the NB, HR and VO_2 was averaged every 30sec during treadmill running. Regression analysis was used to generate a formula that would estimate HR for any given VO_2. An average HR was then calculated over a range of submaximal relative VO_2 values (10-30 ml/kg/min). At 0wk the average HRV based on the above analysis was 148 ± 1.8 bpm. At 5wk the average HR decreased a significant 4.1%, p=0.002 to 142 ± 1.4 bpm. At 10wk the average HR decreased a significant 5.3%, from 0wk to 140.1 ± 1.8 bpm. (p=0.003). There was no difference between the average HR at 5wk and 10wk, (p=.346). (Figure 4)

Body Composition

Body composition was analyzed at 0wk, 5wk and 10wk using Dual-energy X-ray absorptiometry (DEXA).

Body Mass (BM)

The subject's BM at 0wk was 79.8 ± 7.8kg and ranged from 51.0kg to 118.5kg. The subjects BM were the same at 5wk (p=0.151) and 10wk (p=1.0). (Figure 6)

Percent Body Fat (%BF)

The subject's %BF at 0wk was 36 ± 3.4% and ranged from 17.1% to 48.9%. At 5wk %BF had decreased non-significantly 1.9% to 35.3 ± 3.3% (p=0.165). At 10wk %BF had decreased significantly 5.3%, from 0wk to 34.1 ± 3.4 % (p=0.003). (Figure 5)

Fat Mass (FM)

The subject's FM at 0wk was 30.0 ± 4.9kg and ranged from 9.4kg to 57.9kg. At 5wk FM had decreased non-significantly 1.2%, to 29.7 ± 4.8kg (p=0.631). At 10wk FM had decreased significantly 5.4%, from 0wk to 28.4 ± 4.6kg (p=0.045). (Figure 6)

Lean Body Mass (LBM)

The subject's LBM at 0wk was 46.7 ± 3.52kg and ranged from 30.0kg to 62.3kg. At 5wk LBM had increased a significant .98 kg, to 47.7 ± 3.5kg (p=0.003). At 10wk LBM had increased significantly 1.67 kg (p=.001), from 0wk; and 0.69 kg, from 5wk to 48.4 ± 3.6kg (p=.050). (Figure 6)

Subject Compliance

Subjects reported completing nearly 100% of the assigned training. The only exception was week 10. They averaged 2.2 out of the required 3 workouts in week 10. Subjects averaged 3.3 workouts per week and 33.1 rounds per week.

Discussion

The major finding of this study was that 10 weeks of Nexersys training reduced body fat and increased LBM with no change in body weight. It was also found that the average heart rate during Nexersys and treadmill running for a range of VO_2 values (10-25 and 10-30 ml/kg/min, respectively) was significantly lowered. There was a trend for an increase in VO_2max however this did not reach statistical significance. This is the first and only study done assessing Nexersys training and the subsequent changes in body composition and cardiovascular fitness.

The body composition changes were a 5.3% decrease in %BF caused by a 5.4% (1.62kg) decrease in FM with no change in weight. The fat loss of 1.62 kg was offset by a 1.67kg increase in LBM thus weight stayed the same. This result is similar to that found by Forbes. He found that if an exercise program with an ad libitum diet resulted in an increase in LBM there was either no change or an increase in BM [17]. Subjects did not decrease BM despite increasing their activity level with the use of Nexersys training and presumably daily caloric expenditure. This result was most likely due to an increase in daily caloric intake that offset the increase in daily caloric expenditure. For Nexersys or any other exercise program that would produce a modest increase in daily caloric expenditure to be an effective weight loss tool, daily caloric intake must be maintained or decreased. If the goal of a Nexersys consumer is to lose weight they would be advised to adopt a moderately calorie-restricted diet alongside the Nexersys training.

The only detectable change in cardiovascular fitness (CF) was the average submaximal heart rate during Nexersys and treadmill running for a range of VO_2 values

(10-25 and 10-30 ml/kg/min, respectively) was lowered. Nexersys training largely consists of intensities < 70% VO_2max. The only rounds that were found to have intensities > 70% VO_2max were the cardio rounds. Approximately 1 in 5 rounds is a cardio round in Nexersys preprogrammed bouts. We found that subjects spent 133.3 seconds at intensities above 70% VO_2max per cardio round. For a 5 round 20 minute workout 17.8 minutes (88.9% of the time training) is at intensities below 70% VO_2max. Given that the vast majority of training is at a low to moderate intensity it follows that the majority of improvement in CF would be at these submaximal intensities. We did see a trend towards an increase in VO_2max but it did not reach statistical significance. The ACSM gives minimum threshold intensity for improving VO_2max in moderately trained athletes of ≥70% VO_2max. The participants in this study were sedentary, and therefore had a base fitness less than that of a moderately trained athlete.. There was no trend for an increase in VO_2max at 5wk but there was at 10wk. Had the participants continued training additional weeks at 15-rounds 3-4 times per week this might have been a large enough stimulus for a statistically significant increase in VO_2max.

The average HR during the NB was 79.1% of HRmax. This is much higher than would be expected by an average VO2 of 50% VO_2max. The likely reason for this is that most of the Nexersys training involves striking with the arms. It is known that a small muscle mass (arms) increases HR more than large muscle mass (legs) at the same VO_2. Rotstein showed that when percent heart rate reserve (%HRR) and %VO_2 reserve for arm exercise are calculated from HRmax and VO2max measured during running, the prediction of %VO_2 reserve from %HRR is overestimated [19]. This likely explains why HR during NB stayed high while VO_2 was relatively low.

The Nexersys is likely a better exercise choice than other "exergaming" platforms. The Nexersys requires the use of both arm and leg musculature and elicits an average VO_2 of %50 VO_2max with periods >70% VO_2max. Worley et al found that the Wii Fit did not require VO2 above 30% VO_2max and mainly required the use of arm musculature [15]. If the main goal is to improve CF a series of cardio rounds could be done which would be similar to doing interval or circuit training.

Conclusion

Ten weeks, 3-4 times per week, 5-15 rounds of preprogrammed Nexersys bouts improves body composition by increasing LBM, decreasing FM with no change in BM. This training also lowers average heart rate during submaximal training. VO_2max increased 7.1% but this change failed to reach statistical significance with p=0.054.

Appendix A

Figure 1: Percent heart rate maximum (%HRmax) vs. percent maximal oxygen uptake (%VO2max). Each point represents the 30sec avg %HRmax and %VO_2max. This is an average for all subjects over the three 10-round Nexersys' bouts.

Figure 2: Average maximal oxygen uptake of the subjects at 0wk, 5wk and 10wk (no statistical difference). The difference between 0 and 10 wks was p=0.054.

Figure 3: Average heart rate for oxygen uptake of 10-25 ml/kg/min during the 10-round Nexersys bout. * indicates statistically different from 0wk.

Figure 4: Average heart rate for oxygen uptake of 10-30 ml/kg/min during treadmill running. * indicates statistically different from 0wk.

Figure 5: Individual and average percent body fat at 0wk, 5wk and 10wk. * indicates the average is significantly different from 0wk.

Figure 6: Comparison of average body mass, fat mass and lean mass (bar1, bar2 and bar3, respectively) at 0wk, 5wk and 10wk. * indicates statistically different from 0wk. # indicates statistically different from 5wk.

Table 1: Training schedule. Letter indicates training level B=beginner, I=intermediate, A=advanced. Number indicates number of rounds.

Table 2: Maximal Oxygen Uptake (ml/kg/min) for individual subjects.

Table 3: Individual's data for average heart rate for oxygen uptake of 10-30 ml/kg/min during treadmill running at week 0, week 5 and week 10. * indicates statistically different from 0wk.

Table 4: Individual's data for average heart rate for oxygen uptake of 10-25 ml/kg/min during the 10-round Nexersys bout at week 0, week 5 and week 10. * indicates statistically different from 0wk.

Table 5: Individual's body mass (kg) at week 0, week 5 and week 10. * indicates statistically different from 0wk.

Table 6: Individual's percent body fat at week 0, week 5 and week 10. * indicates statistically different from 0wk.

Table 7: Individual's fat mass (kg) at week 0, week 5 and week 10. * indicates statistically different from 0wk.

Table 8: Individual's lean body mass (kg) at week 0, week 5, and week 10. * indicates statistically different from 0wk.

Appendix B

Figure 1

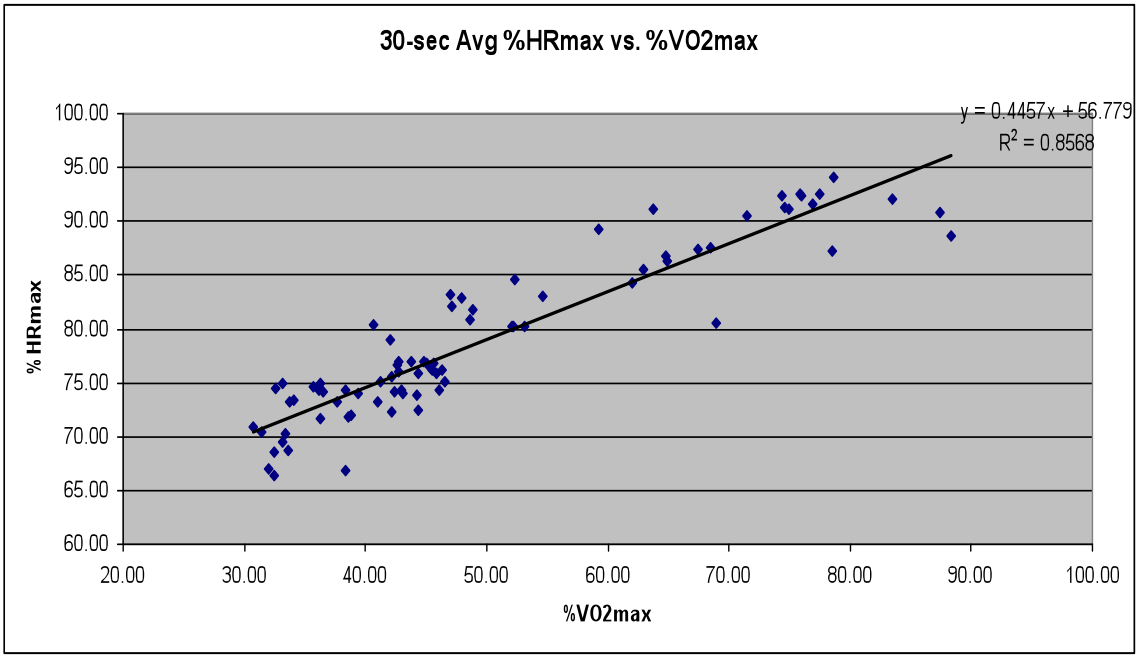

Figure 2

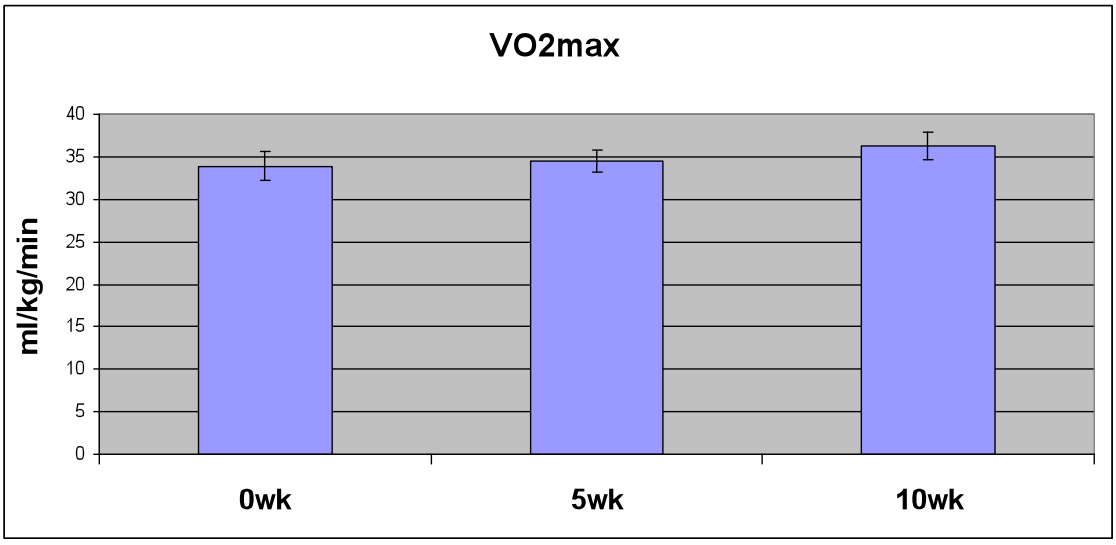

Figure 3

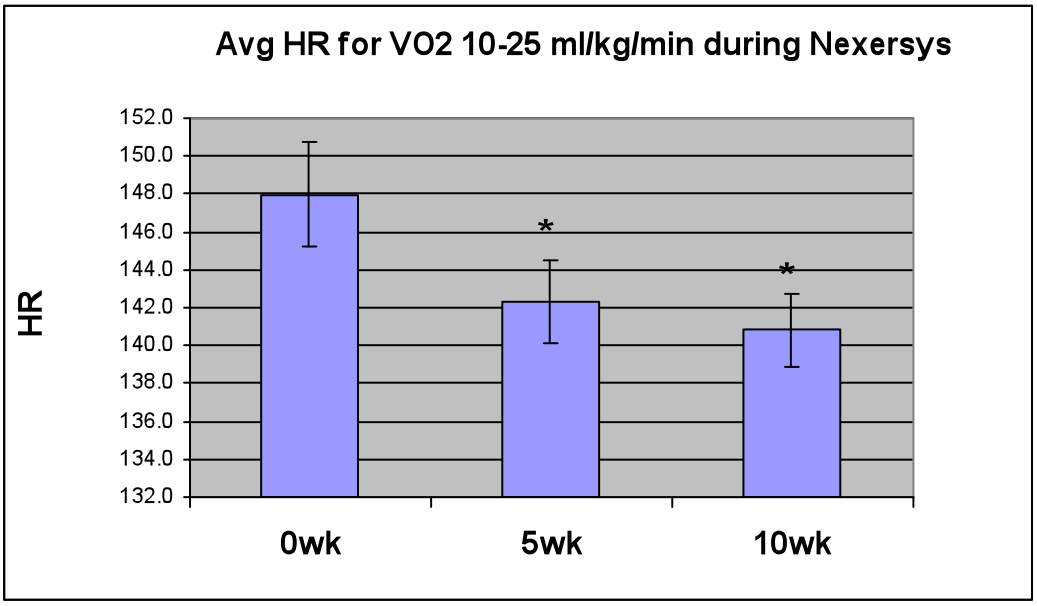

Figure 4

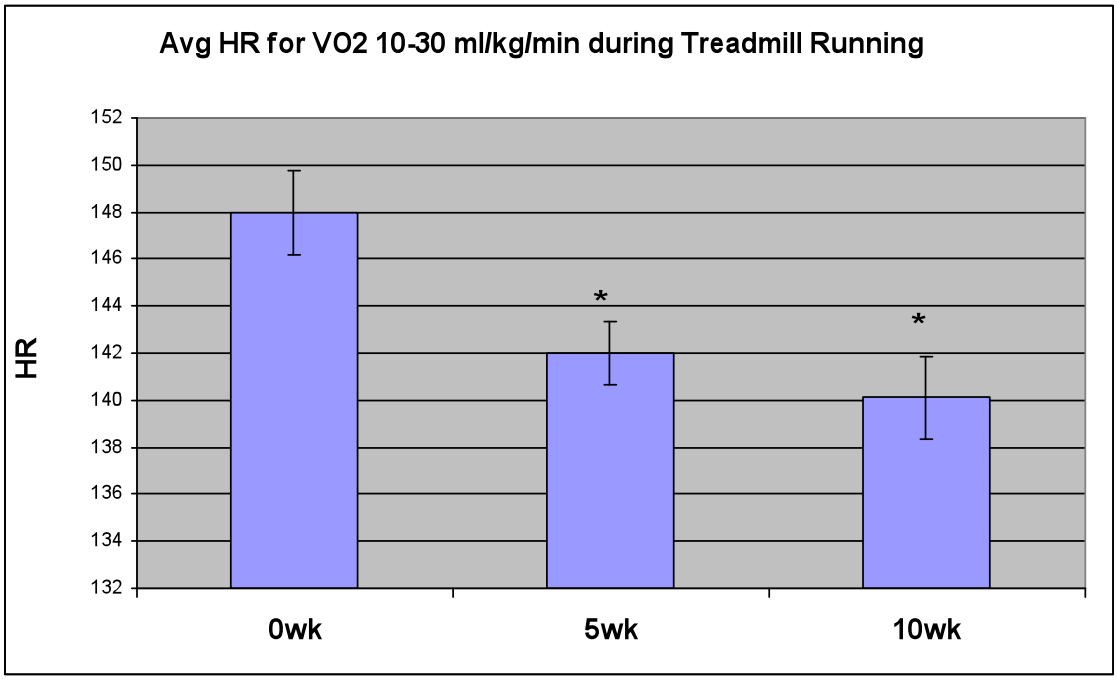

Figure 5

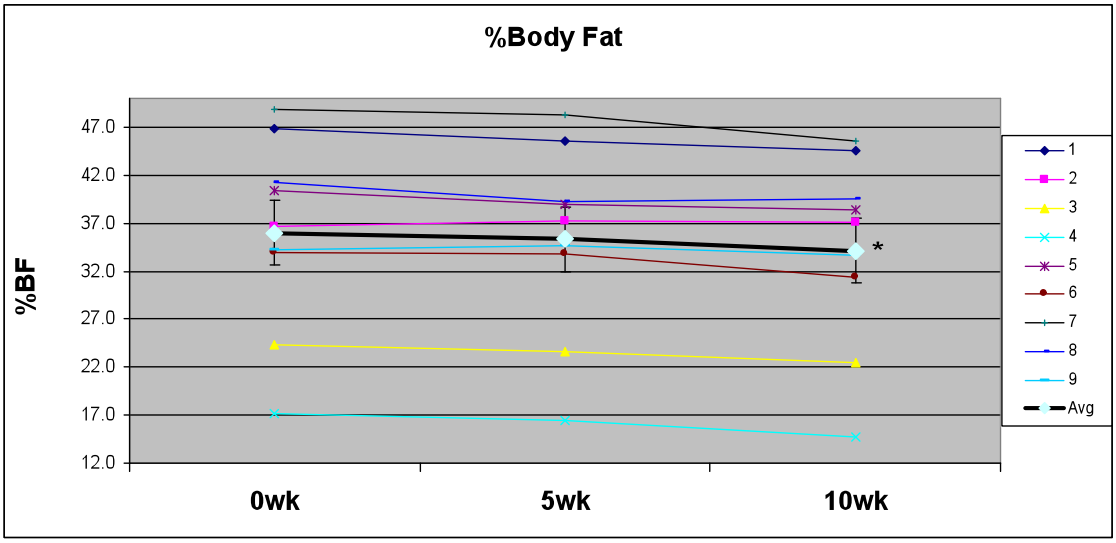

Figure 6

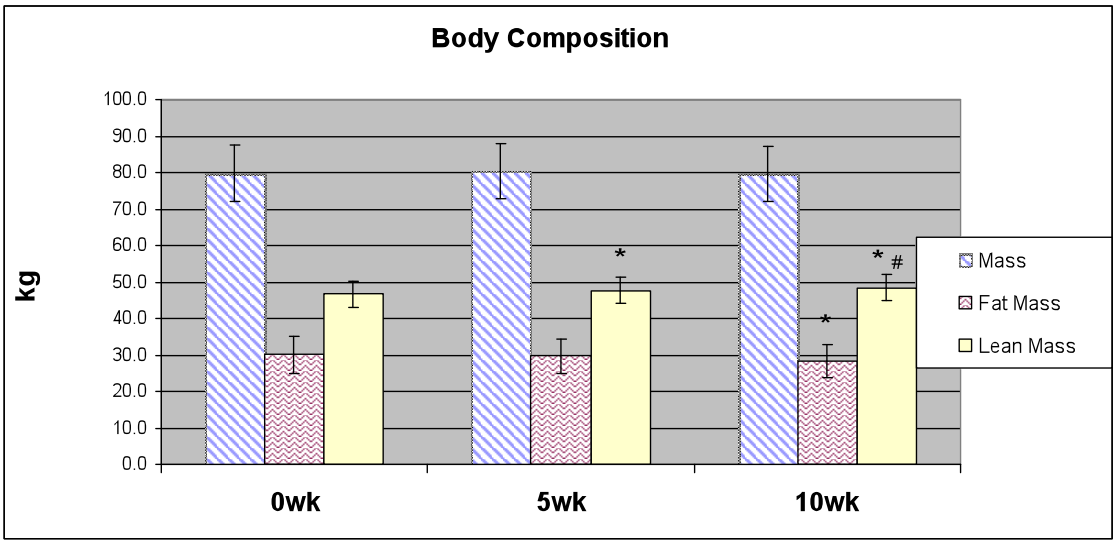

Table 1

	1	2	3	4
Week 1	B5	B5	I5	
Week 2	I5	A5	A5	B7
Week 3	B7	I7	I7	
Week 4	A7	A7	B9	B9
Week 5	I9	I9	A9	
Week 6	**Test**	A9	B12	B12
Week 7	I12	I12	A12	
Week 8	A12	B15	B15	I15
Week 9	I15	A15	A15	
Week 10	A15	A15	A15	**Test**

Table 2

Maximal Oxygen Uptake (ml/kg/min)

Subject	**Week 0**	**Week 5**	**Week 10**
1	29.7	30.4	32.1
3	37.9	40.7	43.6
4	41.8	36.5	41.8
5	27.1	32.5	32.3
6	37.7	35.3	39.8
7	32.7	30	32.1
8	33.7	36.3	35.5
9	30.5	34.5	33
Average	**33.9**	**34.5**	**36.3**
SE	**1.7**	**1.2**	**1.7**
% Change		**1.8%**	**7.1%**

Table 3

Average Heart rate during treadmill running for VO2 10-30 ml/kg/min (bpm)

Subject	Week 0	Week 5	Week 10
2	152.9	151.9	142.2
3	139.2	130.4	125.5
4	154.8	140.7	127.8
5	166.3	151.6	151.9
6	144.7	132.8	133.8
7	143.9	137.7	136.1
8	135	146.2	151.1
9	147.2	144.6	152.3
Average	**148**	**142***	**140.1***
SE	**1.8**	**1.4**	**1.8**
% Change		**-4.1%**	**-5.3%**
		p=0.002	**p=0.003**

Table 4

Average Heart Rate during Nexersys Bout for VO2 10-25 ml/kg/min (bpm)

Subject	Week 0	Week 5	Week 10
1	169.2	162.7	160.4
2	149	150.5	140.1
3	127.8	125.1	127.8
4	151.1	134.3	127.8
5	166.1	150.6	146.1
6	151.1	143.3	143.3
7	132	135.8	137.2
9	137.5	136.1	144.1
Average	**148**	**142.3***	**140.8***
SE	**2.7**	**2.2**	**1.9**
% Change		**-3.9%**	**-4.9%**
		p=0.001	**p=0.003**

Table 5
Body Mass (kg)

Subject	Week 0	Week 5	Week 10
1	79.2	80.2	79.8
2	51	52.4	53.1
3	59	58.8	58.4
4	54.7	56.1	55.8
5	100.3	101.3	100.2
6	101.5	101.5	98.8
7	118.5	118.2	117.5
8	71.1	70.8	71.7
9	82.5	83.8	82.2
Average	**79.8**	**80.3**	**79.7**
SE	**7.8**	**7.7**	**7.5**
% Change		**0.6%**	**-0.1%**

Table 6
Percent Body Fat (%)

Subject	Week 0	Week 5	Week 10
1	46.8	45.5	44.5
2	36.7	37.3	37.1
3	24.4	23.6	22.4
4	17.1	16.5	14.7
5	40.4	38.9	38.4
6	34	33.8	31.3
7	48.9	48.3	45.6
8	41.3	39.2	39.6
9	34.2	34.7	33.6
Average	**36**	**35.3**	**34.1***
SE	**3.4**	**3.3**	**3.4**
%Change		**-1.9%**	**-5.3%**
			p=0.003

Table 7
Fat Mass (kg)

Subject	Week 0	Week 5	Week 10
1	37.1	36.5	35.5
2	18.7	19.6	19.7
3	14.4	13.9	13.1
4	9.4	9.3	8.2
5	40.5	39.4	38.5
6	34.5	34.3	30.9
7	57.9	57.1	53.6
8	29.3	27.8	28.4
9	28.3	29.1	27.6
Average	**30.0**	**29.7**	**28.4***
SE	**4.9**	**4.8**	**4.6**
% Change		**-1.2%**	**-5.4%**
			p=0.045

Table 8
Lean Body Mass (kg)

Subject	Week 0	Week 5	Week 10
1	39.3	41.0	41.5
2	30.0	30.6	31.2
3	42.1	42.5	42.9
4	43.0	44.5	45.3
5	56.6	58.7	58.5
6	62.3	62.4	63.4
7	56.8	57.6	60.4
8	38.9	40.3	40.4
9	51.4	51.7	51.7
Average	**46.7**	**47.7***	**48.4***
SE	**35.2**	**35.0**	**35.9**
%Change		**2.1%**	**3.6%**
		p=0.03	**p=0.001**

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